edge found in the works of Shakespeare. The volume closes with a biographical and critical estimate of Descartes, and a similar account of Robert Mayer, his life, and the trials which he experienced in the promulgation of his views on energy.

The same wide knowledge of curious matters pertaining to science pervades the briefer articles, even the titles of which can not all be quoted. Saint Augustin on quicklime, the superstitions connected with the mandragora, the mystery of the "coasts of Bohemia" (Winter's tale), which is solved by a remark encountered while reading for his "History of Sugar," are all delightful. A note on Who introduced the experiment of burning of a watch spring in oxygen, shows that it was Jan Ingen-Housz (1730–1799), better known as the discoverer of the fact that plants breathe oxygen and generate carbonic acid, in addition to assimilating the latter as food. Amongst the other papers are interesting biographies of Marggraf and Achard, and a curious report on the profits which Edward Howard (brother of the Duke of Norfolk) derived from the invention of the vacuum evaporating apparatus. Several articles deal with subjects connected with sugar. But the author is more than a sugar-chemist and his book can be recommended most heartily to all who are interested in the history of science.

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Die Zustandsgleichung der Gase und Flüssigkeiten und die Kontinuitätstheorie. Von Professor Dr. J. P. Kuenen in Leiden. Braunschweig, F. Vieweg und Sohn. 1907. Pp. x + 241.

Professor J. P. Kuenen, now at Leyden, and recently at University College, Dundee, is a man whose experience has peculiarly fitted him for the task of writing this book, as might be inferred from an examination of the book itself. The "equation of state" which was devised by J. D. van der Waals, of Amsterdam, in 1873, and which bears his name, is an equation which attempts to give in a compact form, the laws controlling the variations of volume, pressure and temperature of all gases, not only when they are far removed from the critical condition, but even at and near the critical point as well. It is usually written

$$(p + a/v^2)(v - b) = RT$$

where a, b and R are constants for any one gas, and p is the pressure, v the volume of unit mass, or specific volume, and T is the absolute temperature of the gas. This equation is a vast improvement over anything that preceded it, particularly the equation of so-called perfect or ideal gases, representing Boyle's and Charles's laws, and is a landmark in the history of physics, but it nevertheless does not represent the facts with complete success. It seems indeed as if it must always remain impossible to represent by one equation containing only a moderate number of constants, the complexity of real gases, for real gases are simple only when compared with liquids or solids, or when their complexities are overlooked, and we regard merely their most important characteristics. The equation has, however, been of marked service in showing the relation between different gases, and between various phenomena of gases, particularly those connected with their behavior when near the critical point, and when they depart most from the simple laws of ideal gases.

Professor Kuenen's book begins with a general statement of the phenomena attending the condensation of gases into liquids. He shows how the elementary kinetic theory of gases explains their behavior when far above the critical point. He then shows, following van der Waals, how this simple theory may be modified by a consideration of the finite size of the molecules of a gas and the forces of attraction which may exist between them. The equation of state having been obtained, it may be used to throw considerable light on the phenomena of condensation, conditions of unstable equilibrium, etc. Several chapters are devoted to what is perhaps the most important thing to be considered, the agreement between the equation and experimental facts. In these chapters are considered the law of corresponding states, critical constants, behavior at high pressure, saturation pressures, Joule-Kelvin researches, specific heats, etc.

The book also considers the various attempts that have been made to improve the equation of van der Waals, and the equations of state proposed by others. The last chapter gives the mathematical methods by which the equation of van der Waals may be deduced.

The book is a valuable monograph on the subject of which it treats and brings together a large amount of information that otherwise could be found only by a laborious search through journals. At the end of each chapter, and in footnotes, are given full references to the literature of the subject treated of in the chapter. At the end of the book there is an index of names but not of subjects. The need of a subject index is satisfied in part by a full table of contents in the front of the book. A book of this kind, however, has a valuable use as a reference book, and for such a use the lack of a good subject index is a serious shortcoming, which is felt keenly in proportion to the value of what the book contains. It is only a book to which no one wishes to refer that does not need a subject index. W. S. D.

Plant Anatomy from the Standpoint of the Development and Functions of the Tissues and Handbook of Micro-technic. By W. C. STEVENS. 8vo. Pp. xii + 349. With 136 illustrations. Philadelphia, P. Blakiston's Son & Co. 1907.

As is indicated by the title of this book, the standpoint adopted is the physiological one; in fact, the book might have been named Anatomical or Structural Physiology. The titles of many of the chapters indicate this, *e. g.,* Construction of the Plant's Food, Secretion and Excretion, and the general method of discussion is to describe the process, then the structures concerned. No doubt this is a useful standpoint, and the method of treatment is appropriate, but it seems a pity that the bearing of anatomy on the great problems of morphology should be altogether ignored. Since the book is in no sense a work on comparative anatomy, we find no reference to the structure of fossil plants.

Within the scope of 217 pages the author gives a clear though necessarily brief and elementary account of the main processes and structures of the so-called vegetative parts of a higher plant. The first three chapters describe the development of the tissues from the undifferentiated cell, through the stages of meristem, primary structure and secondary growth. In the main the account is clear and accurate as far as it goes, and is much aided by the carefully executed and elaborate diagrams which illustrate such features as the primary and secondary structure of stems. The diagrams throughout the book are in fact one of its most noteworthy and valuable features. The description of vascular bundles may be adequate from the author's standpoint, but it seems strange to see no reference to protoxylem, nor figures of amphicribral and bicollateral bundles. Several well-chosen "illustrative studies" conclude each chapter.

Protection from Injuries and Loss of Water and The Plant Skeleton are next considered. The treatment here is too brief and incomplete to give the student an intelligent idea of the important ecological adaptations which might be discussed under these heads. Loss of water through stomata is not treated here, as one might expect, but is deferred to a later chapter.

The absorption, circulation and storage of water, gases and foods are the topics discussed in chapters VI. to XI. By means of numerous ingenious diagrams the leading facts are presented in so lucid a way that he who runs may read. A possible exception to this statement may be found in Fig. 94, in which the perspective is faulty. Moreover, it may be questioned whether this diagram as well as some others does not try to show too much. Owing to the standpoint of the book we might expect to find under the heading of circulatory tissues some reference to Strasburger's brilliant discovery of the substitutes for companion cells in the phloem of *Pinus,* but instead of this we find the erroneous statement (p. 162): "In gymnosperms and vascular cryptogams the companion cells do not occur, and their place is taken by vertical rows of parenchyma cells." A series of illustrative studies concludes each chapter of this section.

A chapter on Secretion and Excretion con-